MEMORANDUM

TO: Docket

FROM: EPA, Clean Air Markets Division

SUBJECT: Economic & Energy Analysis for the Proposed Interstate Air Quality Rulemaking

DATE: January 28, 2004

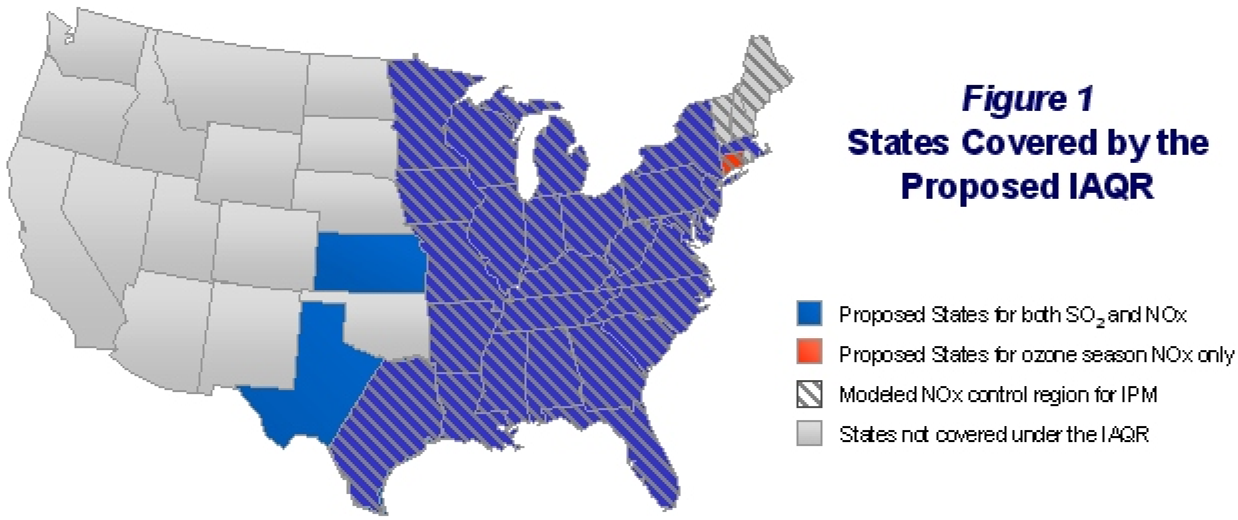
This memorandum reports the economic and energy impact analysis performed for the proposed Interstate Air Quality Rulemaking (IAQR). EPA used the Integrated Planning Model (IPM), developed by ICF Consulting, to conduct its analysis. IPM is a dynamic linear programming model that can be used to examine air pollution control policies for mercury and other pollutants throughout the contiguous U.S. for the entire power system. Documentation for IPM can be found at www.epa.gov/airmarkets/epa-ipm.

Background

Because the economic analysis was begun before EPA made a final determination regarding the States affected by the Proposed IAQR, analysis was performed on a slightly different region than the region covered by today's rulemaking. The analysis covers the electric power industry, a major source of SO_2 and NOx emissions nationwide and the industry that EPA proposes to control in the proposed IAQR cap-and-trade program (see Figure 1).

For SO_2, we modeled a nation-wide control strategy with a nation-wide cap of 4.5 million tons in 2010 and a nation-wide cap of 3.15 million tons in 2015. The proposed strategy requires caps of 3.9 million in 2010 and 2.7 million tons in 2015 in 28 States and the District of Columbia in the eastern part of the country. Since almost all of the SO_2 emission reductions occur in the proposed region, the larger modeling region still provides a very good estimate of the impacts of the SO_2 reductions on the smaller proposed region.

For NOx, the modeled region included the eastern half of Texas, Minnesota, Iowa, Missouri, Arkansas, and Louisiana and all of the States to the east (Figure 1). The caps modeled for this region are very close to the caps proposed in the IAQR, and EPA believes that this modeling provides a very good estimate of the impacts of the NOx reductions on the proposed region.



Projected SO_2 and NOx Emissions and Reductions

Because of the existence of a bank of allowances under the Title IV Acid Rain Program that sources will be allowed to use under the proposed requirements of the IAQR, emissions in 2010 and 2015 will be higher than the caps that are being proposed in the IAQR.

Table 1
Projected Emissions of SO_2 and NOx with the Base Case[1] (No Further Controls) and with the Proposed IAQR
(Million Tons)

		2010			2015			2020		
	Coverage	Base Case	Proposed IAQR	Emission Reduction	Base Case	Proposed IAQR	Emission Reduction	Base Case	Proposed IAQR	Emission Reduction
SO_2	Nationwide	9.7	6.0	3.8	9.1	5.3	3.8	8.8	4.3	4.5
	IAQR Region	9.0	5.3	3.6	8.3	4.6	3.7	8.1	3.7	4.4
NOx	Nationwide	3.9	2.5	1.4	4.0	2.2	1.7	4.0	2.3	1.7
	IAQR Region	3.1	1.7	1.4	3.2	1.5	1.7	3.2	1.5	1.7

Note: Numbers may not add due to rounding. The emissions data presented here are EPA modeling results. Actual emission under the proposed IAQR will likely differ slightly because of the difference between the modeled IAQR region and the affected region under the proposed IAQR.
Source: Integrated Planning Model.

Total projected state-level emissions for SO_2 and NOx for both the base case and the proposed

[1] Base case includes Title IV Acid Rain Program, NO_X SIP call and state rules finalized before March 2003.

IAQR are included in Appendix Tables A-1 and A-2 respectively, at the end of this memo.

Projected Costs

For the proposed region, EPA projects that the annual incremental costs of the proposed IAQR are $2.9 billion in 2010 and $3.7 billion in 2015. In 2020, the annual costs are $4.9 billion. This represents a 4.5% increase in production cost in 2010 and a 5.1% increase in 2015 over the base case, which assumes no further pollution requirements on the industry beyond what exists as of March 2003. The cost of electricity production represents roughly one-third to one-half of total electricity costs, with transmission and distribution costs representing the remaining portion. A better impact measure is the impact on electricity pricing, which is shown in a later table.

Projected Control Technology Retrofits

The proposed IAQR is projected to require the installation of an additional 63 GW of flue gas desulfurization (scrubbers) on existing capacity for SO_2 control and an additional 46 GW of selective catalytic reduction (SCR) on existing capacity for NOx control by 2015 (Table 2). The first phase of the proposed IAQR will result in 49 GW of additional scrubbers and 24 GW of SCR by 2010. Most of the NOx reductions achieved in the first phase of the rule can be attributed to the large pool of existing SCR that are used during the ozone season in the NOx SIP call region that, for relatively little cost, run the SCRs year-round.

Table 2
Pollution Control Installations by Technology with the Base Case (No Further Controls) and with the Proposed IAQR
(GW)

	Base Case Total (Cumulative)			Incremental with Proposed IAQR			Total with Proposed IAQR (Cumulative)		
Technology	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**
Scrubbers	115	120	123	49	63	90	164	183	213
SCR	116	125	129	24	46	44	140	171	173

Note: Numbers may not add due to rounding. Base Case retrofits include existing scrubbers and SCR as well as additional retrofits for the Title IV Acid Rain Program, the NOx SIP call, NSR settlements, and various State rules.
Source: Integrated Planning Model.

Emission Reductions and Associated Costs

Table 3 shows the reductions in SO_2 and NOx emissions by control option and the associated costs of those reductions in 2015. Some reductions are due to coal-switching, however, the reductions required by the proposed IAQR must be achieved through the installation of considerable pollution controls. For SO_2, most reductions are achieved through new FGDs, with a small amount of coal switching to lower sulfur subbituminous coal or shifts in generation. For NOx, existing SCRs account for a considerable amount of the reductions, with most of the rest achieved through new SCRs.

Table 3
Approximate Regional Emissions Reductions and Incremental Costs by Control Option for the Proposed IAQR from the Base Case (No Further Controls) in 2015

	SO_2 (thousand tons)	NOx (thousand tons)	Cost (million \$1999)
New SCR	-	784	884
New Scrubber	2,958	-	2,370
Annual Use of Existing SCR	-	890	156
Fuel Switching and Generation Shifts	713	39	332
Total	3,671	1,713	3,742

Note: Numbers may not add due to rounding.
Source: Integrated Planning Model.

The combination of both an FGD and an SCR to control emissions of SO_2 and NOx, respectively, can lead to reductions in mercury emissions. Mercury emissions are projected to decrease to 34 tons in 2010, 33 tons in 2015, and 30 tons in 2020 as a result of the FGD and SCR controls installed for the proposed IAQR.

Projected Generation Mix

Table 4 shows the generation mix with the proposed IAQR. Coal-fired generation and natural gas-fired generation are projected to remain relatively unchanged due to the phased-in nature of the proposed IAQR, which allows industry the appropriate amount of time to install the necessary pollution controls.

Relative to the Base Case, about 3.2 GW of coal-fired capacity is projected to be uneconomic to maintain (about 1%) and about 170 MW of coal-fired capacity is projected to repower to natural gas. The uneconomic coal plants are partly a consequence of the recent overbuild of new gas-fired combined-cycle plants since 2000. Notably, the IPM model can determine that specific generating units are uneconomic to maintain, based on their fuel, operating and fixed costs, and whether they are needed to meet both demand and reliability reserve requirements. In practice, units projected to be uneconomic to maintain may be “mothballed”, actually retired, or kept in service to ensure transmission reliability in certain parts of the grid. Our modeling is unable to distinguish between these potential outcomes. "Repowering" converts units to combined-cycle natural gas or IGCC.

Table 4
Generation Mix with the Base Case (No Further Controls) and with the Proposed IAQR
(Thousand GWhs)

Generating Fuel Use	2010			2015			2020		
	Base Case	Proposed IAQR	Percent Change	Base Case	Proposed IAQR	Percent Change	Base Case	Proposed IAQR	Percent Change
Coal	2,165	2,139	-1%	2,207	2,172	-2%	2,237	2,172	-3%
Oil/Natural Gas	851	876	3%	1,121	1,155	3%	1,439	1,503	4%
Other	1,180	1,179	-	1,178	1,179	-	1,176	1,175	-

Source: Integrated Planning Model.

Projected Coal Production for the Electric Power Sector

Coal production for electricity generation is expected to increase from 2000 levels, with or without the proposed IAQR (Table 5). The reductions in emissions from the power sector will be met through the installation of pollution controls for SO_2 and NOx removal. The pollution controls can achieve up to a 95% SO_2 removal rate, which allows industry to rely more heavily on local bituminous coal in the Eastern and Central parts of the country which has a higher sulfur content and is less expensive to transport than Western subbituminous coal.

Table 5
Coal Production for the Electric Power Sector with the Base Case (No Further Controls) and with the Proposed IAQR
(Million Tons)

Supply Area	2000	Base Case			Proposed IAQR		
		2010	2015	2020	2010	2015	2020
Appalachia	*299*	318	306	286	312	313	306
Interior	*131*	177	174	189	198	203	229
West	*475*	535	571	594	505	516	489
National	*905*	1,029	1,051	1,070	1,015	1,031	1,024

Source: Integrated Planning Model.

Projected Retail Electricity Prices

Retail electricity prices for the IAQR region are projected to increase a small amount with the proposed IAQR (Table 6). A cap-and-trade approach, as proposed in the IAQR, allows industry to meet the requirements of the IAQR in the most cost-effective manner, thereby minimizing the costs passed on to consumers. Regional retail electricity prices are projected to be 2-3% higher with the IAQR.

Table 6
Projected Regional Retail Electricity Prices with the Base Case (No Further Controls) and with the Proposed IAQR
(Mills/kWh)

Year	Base Case	Proposed IAQR	Percent Change
2010	57	58	2%
2015	60	62	3%
2020	61	63	2%

Source: Retail Electricity Price Model.

Retail electricity prices by NERC region are in Table 7, and show small increases in retail prices for the NERC regions in the Eastern part of the country. By 2020, nationwide retail electricity prices are projected to be less than 2% higher with the proposed IAQR.

Table 7
Retail Electricity Prices by NERC Region with the Base Case (No Further Controls) and with the Proposed IAQR
(Mills/kWh)

			Base Case			Proposed IAQR			Percent Change		
Power Region	*Primary States Included*	*2000*	2010	2015	2020	2010	2015	2020	2010	2015	2020
ECAR	OH, MI, IN, KY, WV, PA	*57.4*	51.2	55.0	56.6	53.4	58.6	58.8	4.3%	6.6%	3.9%
ERCOT	TX	*65.1*	54.4	64.5	66.3	54.7	65.1	66.8	0.5%	0.9%	0.8%
MAAC	PA, NJ, MD, DC, DE	*80.4*	58.5	67.5	74.1	60.3	70.2	75.4	3.1%	3.9%	1.7%
MAIN	IL, MO, WI	*61.2*	53.0	57.2	62.6	54.6	60.7	64.1	3.0%	6.1%	2.5%
MAPP	MN, IA, SD, ND, NE	*57.4*	54.5	50.9	49.0	55.4	51.9	49.8	1.7%	1.9%	1.7%
NY	NY	*104.3*	80.4	87.9	90.8	82.0	89.9	91.0	2.1%	2.3%	0.2%
NE	VT, NH, ME, MA, CT, RI	*89.9*	71.8	77.8	84.1	72.7	79.7	84.3	1.3%	2.5%	0.2%
FRCC	FL	*67.9*	71.1	70.2	68.6	72.2	71.2	69.8	1.5%	1.4%	1.7%
STV	VA, NC, SC, GA, AL, MS, TN, AR, LA	*59.3*	55.8	54.7	54.7	56.5	55.7	56.0	1.2%	2.0%	2.4%
SPP	KS, OK, MO	*59.3*	51.7	53.0	56.4	52.5	53.7	57.0	1.7%	1.4%	1.1%
PNW	WA, OR, ID	*45.9*	50.2	49.1	48.6	50.5	49.3	48.7	0.4%	0.2%	0.2%
RM	MT, WY, CO, UT, NM, AZ, NV, ID	*64.1*	62.9	64.4	65.5	63.5	64.6	65.8	1.0%	0.4%	0.4%
CALI	CA	*94.7*	96.0	97.0	97.5	96.5	97.2	97.8	0.5%	0.2%	0.3%
National	Contiguous Lower 48 States	*66.0*	59.5	62.2	63.9	60.6	63.8	65.0	1.9%	2.6%	1.7%

Source: Retail Electricity Price Model. 2000 prices are from EIA's AEO 2003.

Projected Fuel Price Impacts

The impacts of the IAQR on coal and natural gas prices before shipment are in Table 8. The increase in coal prices is a result of a shift towards higher priced mine mouth coal and not from increases in actual coal supply region costs.

Table 8
Average Coal Mine Mouth and Henry Hub Natural Gas Prices with the Base Case (No Further Controls) and with the Proposed IAQR
(1999$/mmBtu)

Fuel	*2000*	Base Case			Proposed IAQR			Percent Change		
		2010	2015	2020	2010	2015	2020	2010	2015	2020
Coal	*0.80*	0.60	0.57	0.55	0.61	0.58	0.57	1.7%	1.8%	3.6%
Natural Gas	*4.15*	2.97	2.96	2.87	3.06	3.00	2.92	3.0%	1.4%	1.7%

Note: Prices for various coals are not increasing, but the mix is changing towards coals that have higher mine mouth prices.
Source: Integrated Planning Model. 2000 coal and natural gas data is from Platts COALdat and GASdat.

Effects of Assumptions for Natural Gas Prices, Electricity Growth, and SCR Costs

Sensitivity analyses were performed using the Energy Information Agency's (EIA) assumptions for natural gas, electricity growth, and SCR costs. These particular assumptions involve higher natural gas prices, an electricity growth of 1.86% a year rather than EPA's growth of 1.55%, and SCR costs scaled up by roughly 60%. Total annual costs of the proposed IAQR with EIA assumptions are in Table 9. The costs of the proposed IAQR with EIA assumptions for natural gas prices and electricity growth in 2010 and 2015 are slightly lower than the costs of the proposed IAQR without those assumptions, and can be attributed to the building of new and cleaner coal-fired capacity that leads to lower overall costs. As demand continues to grow, coal-fired generation increases and requires the use of additional scrubbers, which increase the annual costs in 2020.

Table 9 Projected Annual Regional Costs of the Proposed IAQR with EIA Assumptions for Natural Gas and Electricity Growth *(Billion $1999)*		
Year	**Proposed IAQR**	**Proposed IAQR with EIA Assumptions for Gas & Growth**
2010	$2.9	$2.8
2015	$3.7	$3.6
2020	$4.9	$5.7

Note: Incremental annual costs for EPA's sensitivity with EIA assumptions for natural gas prices, electricity growth, and higher SCR costs is not available because no modeling of a base case with those assumptions was done.
Source: Integrated Planning Model.

Table 10 shows emissions of SO_2 and NOx using EIA assumptions.

Table 10 Projected Nationwide Emissions of SO_2 and NOx under the Proposed IAQR with and without EIA Assumptions for Natural Gas, Electricity Growth, and SCR Costs *(Million Tons)*						
	SO_2			**NOx**		
	2010	**2015**	**2020**	**2010**	**2015**	**2020**
Proposed IAQR	6.0	5.3	4.2	2.5	2.2	2.3
Proposed IAQR with EIA Assumptions for Gas & Growth	5.9	5.4	4.0	2.5	2.3	2.4
Proposed IAQR with EIA Assumptions for Gas, Growth, and SCR Costs	5.9	5.3	4.0	2.5	2.3	2.4

Note: Numbers may not add due to rounding. The emissions data presented here are EPA modeling results. Actual emission under the proposed IAQR will likely differ slightly because of the difference between the modeled IAQR region and the affected region under the proposed IAQR. Source: Integrated Planning Model.

Coal-fired generation under the proposed IAQR increases using EIA assumptions for natural gas prices and electricity growth, with 5 GW of new coal-fired capacity projected in 2010 and 60 GW in 2015, when compared to the proposed IAQR without EIA assumptions. Tables 11 and 12 show the generation mix and pollution control installations with the IAQR sensitivities.

Table 11 Generation Mix under the Proposed IAQR with and without EIA Assumptions for Natural Gas, Electricity Growth, and SCR Costs *(Thousand GWhs)*									
	Proposed IAQR			Proposed IAQR with EIA Assumptions for Gas & Growth			Proposed IAQR with EIA Assumptions for Gas, Growth, and SCR Costs		
Fuel	2010	2015	2020	2010	2015	2020	2010	2015	2020
Coal	2,139	2,172	2,172	2,241	2,696	3,010	2,240	2,697	3,010
Oil/Natural Gas	876	1,155	1,503	966	894	976	966	892	976
Other	1,179	1,179	1,175	1,181	1,183	1,180	1,182	1,183	1,180

Source: Integrated Planning Model.

Table 12 Incremental Pollution Control Installations by Technology under the Proposed IAQR with and without EIA Assumptions for Natural Gas and Electricity Growth *(Incremental GWs)*						
	Proposed IAQR			Proposed IAQR with EIA Assumptions for Gas & Growth		
Technology	2010	2015	2020	2010	2015	2020
FGD	49	63	90	58	69	106
SCR	24	46	44	26	49	45

Note: Incremental pollution control installations for EPA's sensitivity with EIA assumptions for natural gas prices, electricity growth, and higher SCR costs is not available because no modeling of a base case with those assumptions was done.

Source: Integrated Planning Model.

Limitations of Analysis

EPA modeled a close approximation of the control area proposed in the IAQR and the regulatory requirements under the proposed IAQR cap-and-trade program before all the details of the approach were finalized. The intent was to provide a reasonable approximation of the impacts of the proposed rule, but the results have limitations indicated at the outset of this memo.

EPA's modeling is based on its best judgement for various input assumptions that are uncertain, particularly assumptions for future fuel prices and electricity demand growth. To some degree, EPA addresses the uncertainty surrounding these two assumptions through its sensitivity analysis.

In addition, this modeling analysis does not take into account the potential for advancements in the capabilities of pollution control technologies for SO_2 and NOx removal as well as reductions in their costs over time. Cap-and-trade regulation that provides clear market-based incentives for reductions serves to promote innovation and the development of new technologies.

As configured, the IPM model also does not take into account demand response (i.e., consumer reaction to electricity prices). The increased retail electricity prices shown on Table 7 would prompt end-users to curtail (to some extent) their use of electricity and encourage them to use substitutes[2]. The response would lessen the demand for electricity, lowering electricity prices and reducing generation and emissions.

EPA's latest update of IPM was completed in March of 2003, and does not incorporate any State rules or regulations adopted after that date.

Significant Energy Impact

According to *Executive Order 13211: Actions that Significantly Affect Energy Supply, Distribution, or Use*, this proposed rule is significant because it has a greater than a 1% impact on the cost of electricity production and it results in the retirement of greater than 500 MW of coal-fired generation.

Several aspects of the proposed IAQR proposal are designed to minimize the impact on energy production. First, EPA has proposed a trading program rather than the use of command and control regulations. Second, EPA has proposed compliance deadlines cognizant of the impact that those deadlines have on electricity production. Both of these aspects of the proposed IAQR proposal reduce the impact of the proposal on the electricity sector.

[2]The degree of substitution/curtailment depends on the price elasticity of electricity.

APPENDIX

State Emissions Data

Table A-1 Projected Emissions of SO_2 and NOx with the Base Case (No Further Controls) *(Thousand Tons)*						
	SO_2		Ozone Season NOx		Annual NOx	
State	2010	2015	2010	2015	2010	2015
Alabama	473	416	41	34	134	129
Arkansas	123	123	23	23	53	53
Delaware	46	48	4	4	10	11
District Of Columbia	0	0	0	0	0	0
Florida	233	230	75	82	162	171
Georgia	609	600	27	29	151	153
Illinois	596	534	45	48	170	178
Indiana	662	523	59	61	236	242
Iowa	152	160	36	37	82	87
Kansas	64	65	45	45	101	102
Kentucky	357	357	37	40	194	199
Louisiana	113	113	22	22	50	50
Maryland	232	230	10	11	60	62
Massachusetts	16	16	4	5	10	12
Michigan	381	384	37	41	120	126
Minnesota	85	87	43	46	101	105
Mississippi	73	73	19	20	43	45
Missouri	283	307	44	44	133	141
New Jersey	40	38	5	6	29	30
New York	197	197	25	25	64	66
North Carolina	216	141	23	25	61	62
Ohio	1,236	1,025	61	52	261	256
Pennsylvania	846	806	45	47	208	213
South Carolina	200	196	15	16	65	66
Tennessee	306	310	22	22	103	103
Texas	488	487	103	107	200	200
Virginia	186	185	15	16	55	57
West Virginia	551	485	26	19	155	148
Wisconsin	200	176	47	43	106	97
28 State (+DC) Region	8,965	8,313	958	971	3,116	3,163

Source: Integrated Planning Model. The emissions data presented here are EPA modeling results. Actual emission under the proposed IAQR will likely differ slightly because of the difference between the modeled IAQR region and the affected region under the proposed IAQR.

State Emissions Data (cont'd)

Table A-2
Projected Emissions of SO_2 and NOx with the Proposed IAQR
(Thousand Tons)

State	SO_2		Ozone Season NOx		Annual Nox	
	2010	2015	2010	2015	2010	2015
Alabama	354	334	32	26	74	59
Arkansas	78	78	17	4	38	9
Delaware	34	35	4	4	9	9
District Of Columbia	0	0	0	0	0	0
Florida	193	174	30	28	63	54
Georgia	408	197	30	25	65	52
Illinois	241	258	47	41	113	95
Indiana	373	327	58	31	133	74
Iowa	138	146	14	14	34	35
Kansas	63	60	44	45	101	101
Kentucky	305	282	31	23	74	53
Louisiana	80	80	16	6	37	15
Maryland	67	40	9	11	23	25
Massachusetts	15	10	4	5	10	11
Michigan	370	379	38	40	89	94
Minnesota	71	73	16	18	40	42
Mississippi	73	43	9	7	20	15
Missouri	234	279	27	29	63	69
New Jersey	24	20	5	6	11	14
New York	98	101	24	24	56	53
North Carolina	216	141	27	24	61	54
Ohio	346	290	48	41	113	97
Pennsylvania	173	170	34	33	79	77
South Carolina	163	145	14	13	34	31
Tennessee	258	192	22	14	50	32
Texas	402	365	103	90	197	159
Virginia	159	116	14	15	33	33
West Virginia	221	139	18	16	41	36
Wisconsin	187	168	30	24	69	55
28 State (+DC) Region	5,345	4,641	765	654	1,730	1,452

Source: Integrated Planning Model. The emissions data presented here are EPA modeling results. Actual emission under the proposed IAQR will likely differ slightly because of the difference between the modeled IAQR region and the affected region under the proposed IAQR.